Touch sensitive input devices take advantage of the natural instinct to point at what is wanted.

by Louise C. Shaw

A growing number of computer applications require a man-machine interface that is not satisfied by the conventional computer terminal. For many applications, the keyboard terminal is too unwieldy or complex. Interactive users need a simple, natural communication technique; conventional terminals can be intimidating or discouraging.

Touch sensitive input devices take advantage of a natural instinct to point at what is wanted. When a finger is placed on the surface of a touch-sensitive sensor, the coordinates of the point of contact are transmitted to the host computer; the need for light pens, wands, cursormouse, joy sticks, or digitizer styli are eliminated. Untrained operators can select functions, control commands, or data from a menu displayed on the surface of the sensor. Pictures and ideographs further simplify the process, and transcend language barriers.

The intended application of the touch sensor dictates how and where it is mounted. For an application that requires choosing from a small number of fixed positions, such

WHY TOUCH SENSING?

as a replacement for push-buttons, the mounting can be on a fixed picture or a surface with permanently inscribed legends. For an application that requires a large number of choices, the sensor may be mounted on a computer-driven device. The gas plasma display and conventional crt are commonly used for this purpose.

A typical interactive application uses a question and answer dialogue between the computer and operator. The computer displays the question and the response choices, and the operator touches the item that answers the question. This approach can be extended to include a tree search or hierarchy of menus. In a typical data base access application, the computer may generate and display the names of categories of files. The user touches the name of the category. The computer then reads the coordinates of the touched point, and displays a directory of accessible files for the desired category. A touch by the user signifies the chosen file. Continuing in this manner, a sequence of two or three would lead the untrained operator to a selected data item in a short time. The menu selection technique is a natural method for data entry where menus correspond directly to existing application operations, and occurs, for example, in many retail stores.

In control applications, the computer displays the choices available and thereby simulates a set of push-buttons. Unlike a "real" operator's console with many buttons, the simulated console will only display those buttons that pertain to the situation. In many applications, this reduces the chance for confusion and error.

The use of computer-generated graphics and diagrams coupled with touch input can further simplify the process control operator's console. In the past, dials, clock-like readouts, and numeric displays were common features. Now, a single crt or plasma display presents a block diagram of the major component parts of the process. The operator touches the diagram at the point of interest and the computer responds by displaying the relevant parameters. For small volumes of data entry a computer-generated picture of a numeric keyboard allows "key-

Provisions for helping the user have to be built into the system.

ing in'' of numeric data. The touching of a picture of a speedometer or thermometer scale, for example, allows the user to set an approximate speed or temperature setting without the need for a physical switch or a mechanical joy stick.

POINT TO THE PICTURE

An alternate means of data entry to menu selection and simulated keys or push-buttons is to have pictures of objects generated by the computer. The operator touches that portion of interest in the picture. This allows a customer to walk through a parts replacement catalogue without knowing the technical names of subassembly components. Room reservation or seating reservation systems which display a floor map of rooms or a schematic of the seating arrangement allow a reservation clerk or the customer to make a choice by touching the desired room or seat on the schematic.

It may sound strange to consider the ''resolution of the finger,'' the ''baud rate of the hand,'' or the ''bit storage capacity of the human.'' Still these notions must be considered by the application programmer who designs the programs that use touch input. Ignoring these factors leads to systems that degrade the capabilities touch input possesses. For example, an attempt to use all 80 columns or 30 rows of the display would be disastrous. The selection items on display have to be separated by at least the thickness of the finger. At any instant, the number of available choices and selections should be small (ideally under 10). Too many choices create confusion.

A large selection must be converted into a short sequence of small choices—the hierarchy approach. The wording and structure of diagrams have to be self-explanatory to the uninitiated user. Provisions for helping the user have to be built into the system. The user must be offered more information or details upon request. When the system detects erroneous or invalid input, it must explain to the user how to insert correct information. Aborting the session or simply stating that the input is wrong is not adequate. Clearly stated diagnostic messages and illustrative examples must be available. The user has to have an obvious means at his disposal to correct or change his inputs. The ''erase'' feature should take the user back to the previous picture frame, not to the beginning of the session. The application program should acknowledge each transaction. If there is no immediate feedback to the user that the system has heard (or felt) the input, frustration or irritation is likely to result.

The underlying design principles are straightforward as long as the programmer remembers there is a human being at the end of the touch sensor.

TOUCH SENSOR TYPES

Several technologies have been used in the design of a touch sensor. The sensors currently available on the market use the properties of diverse physical phenomena. A common technique in the design of touch sensors is to have a signal generated by the sensor travel through some media. The signal is then detected by the sensor. If a finger has been placed on or near the media, the finger modifies or changes the character of the signal. The detector measures the changed characteristics of the signal and determines the presence and position of the finger.

One of the oldest techniques employs infrared (IR) light as the signal method and photo detectors as the signal receiver. The Plato terminals, which have been used extensively for computer assisted instruction (CAI), have employed arrays of IR light emitting diodes mounted on two adjacent sides of a rectangular frame. The frame surrounds a display area. The remaining two sides of the frame have the photo detectors mounted opposite matching IR emitters. If no finger is present, each detector can detect the light of its corresponding emitter on the opposite side of the frame. If a finger is present, the light beam is blocked and the finger is detected.

Another commercially available system uses acoustic surface waves on a transparent surface as the generated signals that are modified by a finger presence. The acoustic waves generated along two sides travel along the surface. A finger on the surface causes the waves to be reflected. An echo detection system, similar to that used in sonar, listens for the echo. The elapsed time between wave creation and echo return is used to compute the position of the finger. The transparent surface is placed over a crt.

Another system that uses a transparent overlay on a crt involves two sheets. One sheet is glass-coated with a transparent resistive substrate. A second sheet is plastic with a transparent conductive layer. This second sheet is near, but not touching, the first sheet. The voltage of a signal depends on the point of contact, and voltage measuring sensors compute the X-Y coordinates of touch.

Some systems have electrically conductive material on the surface of the touch-sensing area. The finger on the surface changes the electrical characteristics of the conductive material. The capacitance and/or resistance of the human body is used to electrically alter the conductive path on the sensor. By measuring the change of electrical signal the finger's presence is detected. By having several conductive circuits on the surface, the identity of the modified circuit locates the position of the finger.

There are many techniques for touch sensing, and each has a definite use and advantage. In the near future, as distributive processing expands, the number of users who can benefit from touch input will increase; the appropriate technology is waiting. ✱

GENERAL DIGITAL
CORPORATION
700 BURNSIDE AVENUE • EAST HARTFORD, CONNECTICUT 06108 • TEL. (203) 528-9041

April 1, 1981

Mr. Ted Nelson, Consultant
P.O. Box 128
Swarthmore, PA 19081

Dear Mr. Nelson:

Thank you for your inquiry about the VuePoint touch-input terminal. We are very pleased with the input we have been receiving from computer specialists such as yourself. Applications for VuePoint seem to be limited only by the imagination of the systems designer.

I think the enclosed brochure should serve to answer your questions about VuePoint's features. The terminal is priced at $3500 in quantities less than 10 and is available in 30 to 60 days after receipt of order. Quantity discount information as well as a programmers manual are available upon request if they would help in your decision process.

Please call me if you should have any questions regarding your application, custom modification or would like any other assistance.

Sincerely,

GENERAL DIGITAL CORPORATION

Stuart H. Hoffer
Vice President - Marketing

SHH:ch

Enc.